Last Updated   Spring 2026

San José State University
Computer Science Department
CS224: Genomic Sequencing & Genome Assembly

Course Information

Instructor:	Leonard Wesley
Office Location:	MH 212
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Office Hours:	Wednesdays 10:00AM – 12 Noon, Zoom Link For Office Hours For Spring 2026 https://sjsu.zoom.us/j/82442818722?pwd=nwmaLCQzpwLaVqHDD6ay9t72tVPjbV.1 PASSCODE: 016303
Class Days/Time:	Section 01: Tue and Thur 3:00 PM –4:15 PM
Classroom:	MH 422
Prerequisites:	CS/BIOL123B or equivalent, Math 161A or equivalent, and be comfortable running UNIX, Windows, or Mac based application software, or instructor consent. Graduate Standing. Allowed Declared Major: Bioinformatics, Computer Science, and Data Science.

Course Description
Genomic concepts and methods of 1st through next-gen and long sequence reads are presented. Current batch and single cell sequencing methods are covered. Collecting, analyzing, and assembly of genomic sequences using de novo, reference-based, and single-cell methods are also presented.

Learning Outcomes

Upon successful completion of this course, students will:

1. **CLO-1 The Early Years:** Learn about pre-1st generation sequencing as well as 1st through Next Generation Sequencing (NGS) technologies.
2. **CLO-2: Current Sequencing Technologies:** Learn about state-of-the-art batch short-sequence sequencing technologies, such as Illumina, through long-sequence sequencing technologies such as PacBio and Oxford Nanopore which claim to reach Q40/Q30 and Q28 read quality standards respectively.
3. **CLO-3: Genome Assembly:** Understand the principles and techniques of de novo and reference genome assembly to build a representation of the sequence or genome from which sequence reads were produced. Students will also learn how to perform de novo and reference assembly using the Spades assembly software within a UNIX based environment.
4. **CLO-4: Gene Annotation & Variant Calling:** Learn how to identify the locations of genes and all of the coding regions in a genome and determine the function of those genes. Students will also learn how to identify and analyze variants in assembled results.
5. **CLO-6: Single Cell Sequencing & Analysis:** Lean the difference between batch and single-cell sequencing (SCS). Students will also learn how to perform analysis of SCS results using tools such as SCANPY and 10x datasets, and how to perform clustering, trajectory, and speed analysis diagnose diseases using SCS tools and techniques.

Each CLO above corresponds to a learning module that is described in the course calendar below. That is, there are five (5) learning modules that cover the CLOs described above.

Required Texts

1. **Next-Generation DNA Sequencing Informatics, Second Edition**   Edited by Stuart M. Brown, *New York University School of Medicine,* Publisher Cold Fall Harbor Laboratory Press, 2015, ISBN 978-1-621821-23-6

2. Guo-Cheng Yuan, **Computational Methods for Single-Cell Data Analysis**, 2019 ISBN 978-1-4939-9056-6 ISBN 978-1-4939-9057-3 (eBook) https://doi.org/10.1007/978-1-4939-9057-3

NOTE: The field is advancing so rapidly that the above-required textbook will be supplemented with more recent publications as appropriate.

Other Optional Reading Material

A Primer of Genome Science, Greg Gibson, Spencer V. Muse, Publisher Sinauer Associates, 2009, Edition #3, ISBN-10: **0878932364** | ISBN-13: **978-0878932368**

Introduction to Computational Biology: Maps, Sequences and Genomes, Michael S. Waterman, CRC Press. (A statistical oriented view of bioinformatics)

Bioinformatics and Functional Genomics, 3rd Edition, Jonathan Pevsner, ISBN: 978-1-118-58178-0, October 2015, Wiley-Blackwell

Course Requirements and Assignments

Course Logistics
Students should expect to spend approximately nine (9) hours per week (on average) outside of the classroom preparing for and completing the assigned course work. This includes reading papers, viewing videos as appropriate, completing homework and programming exercises, and so forth. The amount of time that a student actually spends will depend on individual skills and the time allocated to the course. The nine (9) hours per week estimate is based on previous experiences of the instructor and students. So please plan and schedule accordingly.

Some of the class will be taught in "flipped" mode where lectures will be available online, and students will be expected to view these lectures before class, as a regular part of their out-of-class work. Classes will concentrate on answering questions and performing exercises that allow students to practice and use the skills, tools and concepts covered in the lectures. Students should consult the Canvas website at least twice weekly and complete assignments by the specified deadlines.

Previously, some students have asked for a special exception to policies and procedures for this course. An example includes asking the instructor for extra assignments or work to help improve a grade. Even if such a request is reasonable in the opinion of the instructor, no exception will be given to a student unless it can be made available to the

entire class and does not constitute significant extra work on the part of students,

instructors, graders and so forth. Students should have no concern that other students will receive special exceptions that will not be available to the entire class.

NOTE: University policy F69-24 at http://www.sjsu.edu/senate/docs/F69-24.pdf states that "Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading." However, attendance will be required in order to complete and submit many in-class exercises, quizzes, and exams.

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

Classroom Protocol

Instruction will begin at or within several minutes of the official published start time for the course. Please make sure that cell phones, beepers, and texting devices are turned off during the entire scheduled class time. Excessive audible discussions with fellow students is prohibited so that others are not disturbed. If any subject matter is not understood, please do not hesitate to ask for clarification. If an extended response is necessary to remove doubts, then a request to follow up outside of scheduled classroom instruction time might be made.

Quizzes and Exams

There will be three quizzes, one midterm and a final exam or semester-long project, all of which will count toward the final grade as specified in the "Grades" section below. During quizzes and exams, communication with other individuals via any means is strictly prohibited without the express permission of the instructor. Violations will be met with the full impact of SJSU's academic integrity policy and procedures.

Projects

Several life science or genomics-based projects will be described near the start of the course. Projects will involve applying the skills and knowledge learned in the course to the project. Teams of 2-3 students will be formed to work on a selected project topic. Teams will be required to submit a project proposal before starting on a project, and submit a project report along with working code at the end of the course. Individual student scores on a project will be determined by the content and quality of the contribution of each student toward the project. The score on the course project and project presentation will count toward the final grade (percentage wise) as specified in the "Grades" section below.

Reading, Homework, Programming, In-Class Exercises, Participation

Assignments

Graded reading, homework, programming, and class participation and brief course

feedback assignments will be given almost weekly, and will count toward the final grade. There will be 4 In-class Exercise sessions. These will typically involve forming teams of 2-3 students that work on assigned exercises in the classroom. They provide an opportunity to get started on homework programming assignments that are to be submitted on a designated due date. Participation is mandatory, and scores will count toward final course grade.

Computational Resources

Students are required to make sure that they have access to sufficient UNIX, Windows, or Mac based computational resources (e.g., computers and software) to carry out assignments in the course. An attempt to offer the course with access to sufficient computation resources will be made by the department to support classroom instruction and demonstrations. However, students should be prepared to bring their portable laptops to class with at least 32GB RAM and 300GB of secondary storage available.

Week	Module (CLO)	Date Tue/Thur	Topic
1	1	1/22	Course Introduction Introduction to pre 1st generation sequencing to NGS (e.g., Maxim Gilbert, Sanger, Capillary, Pyro, Ligation, Bridge, Illumina, Ion Torrent, …)
2	1	1/27, 1/29	Introduction to pre 1st generation sequencing to NGS (e.g., Maxim Gilbert, Sanger, Capillary, ,,,)
3	2	2/3, 2/5	Current Sequencing Technologies: (e.g., High-volume capillary, Pyro, Ligation, Bridge, Illumina, Ion Torrent, PacBio, Oxford, Nano-pore) Possible Semester Projects
4	2	2/10, 2/12	Current Sequencing Technologies: (e.g., High-volume capillary, Pyro, Ligation, Bridge, Illumina, Ion Torrent, Nano-pore, PacBio, Oxford,…) **2/12: In Class Hands On Exercise 1: Covers weeks 1 to 4.**
5	3	2/17, 2/19	Introduction to genome assembly. De Novo and reference-based assembly. DeBruijn graphs.
6	3	2/24, 2/26	Introduction to genome assembly. De Novo and reference-based assembly. DeBruijn graphs. **2/26: Quiz 1 Covers Topics From week 1 thru Week 5**
7	3	3/3, 3/5	Introduction to genome assembly. De Novo and reference-based assembly. DeBruijn graphs. Use SPADES software.
8	3	3/10, 3/12	Introduction to genome assembly. De Novo and reference-based assembly. DeBruijn graphs. Use SPADES software. **3/12: In Class Hands On Exercise 2: Covers Exercise 1 to week 7.**
9	3	3/17, 3/19	Introduction to genome assembly. De Novo and reference-based assembly. DeBruijn graphs. Use SPADES software. **3/19: Midterm covers topics from week 1 to week 8.**
10	4	3/24, 3/26	Introduction to gene annotation & variant calling: Using GATK, Haplotypecaller, Varscan2 to handle germline to CNVs.
		3/30-4/3	**SPRING BREAK**
11	4	4/7, 4/9	Introduction to gene annotation & variant calling: Using GATK, Haplotypecaller, Varscan2 to handle germline to CNVs. **4/7: In Class Hands On Exercise 3: Covers Exercise 1 to week 7.**
12	5	4/14, 4/16	Introduction to single cell sequencing (SCS): Difference between bulk and single cell sequencing Technologies to extract single cells, issues and challenges, and correction methods. **4/16: Quiz 2 Covers Topics From quiz 1 thru Week 11**
13	5	4/21, 4/23	Introduction to single cell sequencing (SCS): Stages in single cell sequencing, using 10x datasets.
14	5	4/28,	Introduction to single cell sequencing (SCS): Stages in single cell

		4/30	sequencing and analysis, using 10x datasets. Using SCANPY SCS Python code.
15	5	5/5, 5/7	**5/5: In-Class Exercise 4 (Work on Projects, Q&A)** **5/7: Quiz 3 (~45 mins): Covers From Quiz 2 thru End Of Semester**
			Final Project Report and Code Due To Canvas **Wednesday May 13, 2026 By 11:59PM** **No Final Exam.** **The Project Takes The Place Of The Final Exam**

SCHEDULE FOOTNOTES:
NONE AS OF Fall 2026

Grades *

WRITTEN HOMEWORK (4 at 10 points each)	40 pts
QUIZZES (3 at 40pts each)	120 pts
MIDTERM	100 pts
IN-CLASS EXERCISES (4 at 50pts each)	200 pts
WEEKLY COURSE FEEDBACK (12 at 5pts each)	60 pts
PROGRAMMING ASSIGNMENTS (2 @ 40pts each)	80 pts
FINAL EXAM or PROJECT REPORT & CODE	400 pts

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Total Course Points   =   1,000 pts Total

* The total points for each category might change depending on the number of project teams and assignments. The instructor reserves the right to adjust, with sufficient advanced notice, the above point distribution by ± 5 pts. Such adjustments might be based on the difficulty or simplicity of assignments or quizzes or exams.

Grading Information
Grading Percentage Breakdown
(NOTE: Ranges might change if point totals change)

Grading Percentage Breakdown		
Percent of Total Points	**Points**	**Letter Grade**
96.66%	≥ 967	A plus
93.33%	≥ 933	A
90.00%	≥ 900	A minus
86.66%	≥ 867	B plus
83.33%	≥ 833	B
80.00%	≥ 800	B minus
76.66%	≥ 767	C plus
73.33%	≥ 733	C

70.00%	≥	700	C minus
66.66%	≥	667	D plus
63.33%	≥	633	D
60.00%	≥	600	D minus
59.99%	<	600	F

HOW TO CALCULATE/ESTIMATE YOUR GRADE
If students would like to calculate their numeric grade percentage, the formula is as follows:

Numeric CS 224 Grade Percentage =

$$\frac{Total\ points\ from\ assignments}{Total\ course\ points} x\ 100\%$$

There is no guarantee that grades will be curved. If so, it will be done at the end of the semester. The instructor is already aware that graduate students need to maintain an overall GPA of B or better. Just because a student NEEDS a particular grade doesn't mean that the instructor will automatically GIVE the student that grade. Students must EARN a passing grade based on submitted and evaluated course work.

Extra Credit Options, If Available
There are no extra credit assignments in this course except for completing designated "Advanced" assignments. However, homework assignments and exams might contain extra credit options.

Late Assignment Submission
Late assignments will receive a 25%-point deduction of a graded assignment for each 24hr period after the submission deadline. For example, if an assignment is worth 10 points, and the grade for the assignment is 8/10, and the assignment is submitted one day late, then the point deduction equals 2.5, and the final grade for the assignment is MAX(0, 8 – 2.5) = MAX(0, 5.5) = 5.5.

Receiving An Incomplete (I) Grade
Receiving a grade of incomplete (I) is not automatic. Students must complete at least 80% of course assignments by the end of the semester to be eligible to receive a grade of incomplete. Students must also provide documentation to support the reason for the request to receive an incomplete grade. The instructor reserves the right to make a final decision regarding giving an incomplete grade. If the instructor agrees to give a student an Incomplete grade, the instructor will enter the remaining work to be completed as part of the PeopleSoft grade submission process.

Grade Change Policy
It is a university policy that course grade changes must be made within one semester from the end of the course. Requests for exceptions to this policy must be accompanied with a documented and compelling reason.

University Policies
General Expectations, Rights and Responsibilities of the Student
As members of the academic community, students accept both the rights and responsibilities incumbent upon all members of the institution. Students are encouraged to familiarize themselves with SJSU's policies and practices pertaining to the procedures to follow if and when questions or concerns about a class arises. See University Policy S90–5 at http://www.sjsu.edu/senate/docs/S90-5.pdf and University Grading System Policy F18-5 at http://www.sjsu.edu/senate/docs/F18-5.pdf. More detailed information on a variety of related topics is available in the SJSU catalog, at https://catalog.sjsu.edu/ . In general, it is recommended that students begin by seeking clarification or discussing concerns with their instructor. If such conversation is not possible, or if it does not serve to address the issue, it is recommended that the student contact the Department Chair as a next step.

Dropping and Adding
Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at https://catalog.sjsu.edu/content.php?catoid=2&navoid=98. Add/drop deadlines can be found on the current academic year calendars document on the Academic Calendars webpage at https://www.sjsu.edu/provost/resources/academic-calendars/index.php/ . The Late Drop Policy is available at https://www.sjsu.edu/aars/forms-resources/late-drops.php . Students should be aware of the current deadlines and penalties for dropping classes. Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.

Consent for Recording of Class and Public Sharing of Instructor Material
University Policy S12-7 at http://www.sjsu.edu/senate/docs/S12-7.pdf, requires students to obtain instructor's permission to record the course and the following items to be included in the syllabus:

- "Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission to make audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the intellectual property of the instructor; you have not been given any rights to reproduce or distribute the material."

    o It is suggested that the Syllabus include the instructor's process for granting permission, whether in writing or orally and whether for the whole semester or on a class by class basis.

    o In classes where active participation of students or guests may be on the recording, permission of those students or guests should be obtained as well.

- "Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not publicly share, or upload instructor generated material for this course such as exam questions, lecture notes, or homework solutions without instructor consent."

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/ and Syllabus Information web page at https://www.sjsu.edu/curriculum/courses/syllabus-info.php. Make sure to review these policies and resources.

Academic Integrity

Your commitment, as a student, to learning is evidenced by your enrollment at San Jose State University. The University Academic Integrity Policy S07-2 at http://www.sjsu.edu/senate/docs/S07-2.pdf requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 at https://sjsu.edu/president/docs/PD_1997-03.pdf requires that students with disabilities requesting accommodations must register with the Accessible Education Center (AEC) at http://www.sjsu.edu/aec to establish a record of their disability.